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## MISCELLANEOUS.

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### I.—*Recent Intelligence upon the Frozen Ground in Siberia.* By Prof. K. E. VON BAER, Imp. Ac. Sci., St. Petersburg.

As the Royal Geographical Society of London has taken some interest in the communications it has received on the depth to which the ground at Yakutzk remains in a frozen state, it will, I conceive, be glad to learn the measures adopted by the Imperial Academy of Sciences at St. Petersburg, to ascertain precisely, not only the law which regulates the temperature of the ground to the depth which is affected by the periodical changes of summer and winter, but also the influence of the external air penetrating into the well or shaft at Yakutzk, upon its sides; and, finally, to ascertain the depth which the summer heats, which in Yakutzk are very considerable in respect to its position, generally reach.

As soon as I had laid before the Academy the observations made by the merchant Schergin, which had been communicated to me by Admiral Wrangel, a commission was nominated for the purpose of pointing out the means which were to be applied to carry them on in the most desirable manner. Accordingly the commission recommended that a thermometer of a peculiar construction should be introduced into the side of the well, and placed horizontally, at the several depths of 1, 3, 5, 10, 20, 50, 100, 150, 200, 250, 300, 350 feet: two thermometers, indeed, at each of these depths, close to each other, one of which should be inserted a foot deep, and the other a fathom, so that the difference between the two would show the effect of the air in the shaft on the temperature of the ground. These thermometers are to remain a whole year in their places, and to be observed daily. A note is also to be taken of the depth at which the ground is thawed in the autumn, on the approach of winter, whether in forest ground, or under the dry steppes, in marshy countries, sandy places, &c. &c. Attention is also to be paid to the greatest degree of heat attained by the ground in these several districts, at a foot and a half beneath the surface. These directions were sent as early as February last, to Yakutzk, with orders to inquire whether any competent person could be found there to undertake

these observations. But in all probability the academy will be obliged to send some one thither on purpose, properly qualified. They will also in due time, if the means at their disposal allow of it, direct deeper excavations to be made, to pursue still further the observations on the increase of temperature.

The members of the Royal Geographical Society have very justly observed that the observations of M. Schergin are already sufficient to demonstrate the gradual increase of the temperature, although it appears to be more rapid than has been found in other countries where the ground is not frozen. Nor did the mention I made of the doubts expressed by M. von Buch refer to this point; on the contrary, M. von Buch, in an address which he read to the academy of Berlin in the year 1825, distinctly expressed it as a matter of doubt, whether in a district covered with wood the ground can be in a frozen state at so great a depth as the first excavation in Yakutzk had reached, namely, 91 English feet.

Professor Erman, it appears, is not satisfied with the expression "ground ice" (*bodeneis*, Germ.) which I have proposed. I did so because it seemed to me to embrace all the requisite modifications, and is very concise. It is clear that ground which is totally free from moisture cannot be frozen; but the ground in high northern latitudes is never in this state. Even the sand, though in the arctic summer its surface may now and then be perfectly dry, is yet before the winter begins always saturated with wet. If we examine ground which contains only very little moisture in a frozen state, it is very difficult to detect the ice, as it forms an extremely thin partition between the single particles of the earth. Should the moisture be somewhat more considerable before the freezing comes on, we perceive in its frozen state small pieces of ice, wherever the spaces between the particles of the soil are large enough to admit them. These bits of ice, which look like small crystals, I have particularly noticed between the upper layer of soil which is thawed, and the lower layer in a frozen state. But in the flat marshy districts of the high northern latitudes, which in Russia are called *Fundun* (originally a Finnish word), there is so much water in the ground that the quantity of water frequently exceeds that of the soil mixed with it. If in the summer you drive a pole into the turf, which is here formed by the grass, or by the moss, a dirty water, mixed with soil, spurts up in a stream to a considerable height. In some places, too, and particularly those which are surrounded by hills, the ground is covered with pure ice. I have seen such a situation in *Nóvaia-Zemlia*, which was entirely covered with perfect fresh-water ice more than a foot thick. This was not a steep cliff covered over with a bed of ice, like that of which Captain Beechey speaks in Kotzebue Sound,

but it lay horizontally upon the ground ; nor was it the least doubtful how this layer of ice had been formed. It was almost entirely surrounded by hills : the water from the melted snow had collected in the hollow, and had been frozen in the winter. In the following spring or summer the ice, before it could be again melted, had been covered with warm soil from the neighbouring hills to the depth of three feet ; and, as in Nóvaia-Zemlia, the increasing temperature of the earth during the summer does not thaw it so deep as three feet, the ice had remained unmelted. From the narrative of Admiral Wrangel's Journey, which I have read in MS., I observe that similar layers of ice are not rare in the valleys of Siberia. It sometimes indeed happens, as I have observed in Nóvaia-Zemlia, that the ground is penetrated by perpendicular clefts or shafts of ice. These clefts, which are, however, extremely thin, and which I have never found above four inches thick, occur most frequently in loamy soils. This ground in Nóvaia-Zemlia is penetrated by fissures in all directions, which are occasioned by contractions produced by the frost. They are usually from one to three inches in width. Water is collected in them in summer, which is frozen in the following winter ; and if the fissures go to any depth, it is never thawed. This is especially the case if the spot be gradually overgrown with a layer of moss. All these modifications may be comprehended under the term of ground ice, which has also the advantage of allowing of the expression, "perpetual or permanent ground ice," as we speak of perpetual snow. Perpetual ground ice is, then, that which is found in the arctic regions, in that layer of earth which is immediately below that which is thawed by the summer heat, reaching, as this does, to the depth where the temperature of the earth is at freezing-point.

It seems to me very important for physical geography to ascertain the thickness of perpetually frozen ground in countries of which the mean temperature is considerably under the freezing-point. I will merely mention one approximation. If, as is the case at Yakutzk, the ground never thaws at the depth of 300 or 400 feet, all the small streams whose superficial waters only are kept in a liquid state in the summer, must be in winter entirely without water, and *vice versâ*, we may conclude that all rivers which do not come far from the south, and of which the course is entirely within those countries which preserve perpetual ground ice, and yet do not cease to flow in winter, must receive their waters from greater depths than those which remain in a frozen state. It is thus clear that these veins of water penetrate the perpetual ground ice. This circumstance strikes me as not devoid of interest with respect to the theory of the formation of springs, and it would be very desirable that some researches upon this subject

should be set on foot in high northern latitudes. In the narrative of Admiral Wrangel's travels there occurs a remarkable instance of very considerable rivers in very cold countries being without water in winter, like our ditches and inconsiderable brooks. He was riding (to the north of Yakutzk, in about  $65^{\circ}$  N.) over the ice of a pretty considerable river, when the ice suddenly gave way, and his horse sunk: he was himself saved by being thrown on the ice, at the moment his horse fell. He was lamenting the loss of his horse to the Yakutzkers who accompanied him, as he knew not how to get another, when they laughed, and assured him they would soon get his horse back, and with a dry skin too. They got some poles, and broke away the ice, under which the bed of the river was perfectly dry, as well as the horse and his pack. The Yakutzkers were therefore aware that there was no water in the winter time at the bottom of rivers of this size; and in this case the water must have disappeared before the ice had gained sufficient thickness to bear a loaded horse and his rider. Similar accidents and similar results must doubtless have frequently taken place during the many journeys which the English have made in North America; and the agents of the Hudson's Bay Company must be well acquainted with the real state of the small rivers in winter in those high northern latitudes, *i. e.*, whether all of them are in a liquid state below the ice or not; *i. e.*, whether water flows in them under the ice or not.

I am collecting materials to ascertain the *southern* limit of the perpetual ground ice in the Old World. Those I have are not yet very complete; but I am already aware that this phenomenon extends much further in a southerly direction in Siberia than in Europe. I do not believe it has yet been observed in Lapland out of the mountainous districts. Nor did I ever hear of it at Archangel; though Herr Schrenk, a young botanist, who, during last summer travelled through the country of the Samojedes in the suite of the imperial botanist Sartens, and who reached the northernmost extremity of Ural and the island of Waigatz, assured me that on the Petchora the ground at a certain depth is never free from ice. It has long been known that further north the ground is at all times frozen, and a thaw is very rare.

The further we go east, the more southerly do we find the limit of perpetual ground ice. Humboldt found in Boguslowsk, in lat.  $59\frac{3}{4}^{\circ}$  N.,  $60^{\circ}$  E., at the foot of the Ural mountain, small pieces of ice at the depth of six feet in the summer; but Boguslowsk lies very high. No permanent ice has been found in Tobolsk in  $58^{\circ}$  N.; but at Berezov, in  $64^{\circ}$  N., where Erman found the temperature of the ground above  $+ 1$  R., at a depth of 23 feet, we learn from other observations, and particularly those

of a Russian traveller of the name of Belawski, that the lower districts are never without ice in the ground; so that Berezov is probably very near the limit of perpetual ground ice; for it is clear that the peculiarities of soil must have considerable influence in countries which lie near this limit. Further east, this frozen soil extends much more to the southward. Already in the last century, travellers who visited Siberia, and especially Georgi, related that ice remained in the ground throughout the whole year, in the environs of the Lake Baikal, and upon an island in lat.  $52^{\circ}$  N.,  $106^{\circ}$  E. long. It was generally supposed that this circumstance was occasioned by the high mountains surrounding the lake. But Herr von Helmersen has communicated to me some ancient notices, from which it seems that the whole of this south-east angle of Siberia has perpetual ground ice. Captain Frehse, who, according to 'The Berlin Review,' went in search of gold-sand in 1836, states that so early as September, *i. e.*, very little before the beginning of the winter in those latitudes, he found the ground frozen at some distance below the surface, and that this frozen stratum was continued uninterruptedly quite to the under-lying rock, to the depth of from one to six Russian sashén, 42 English feet. But, as at that depth there was always rock, it was not possible to say how thick the layer of frozen earth would be under this latitude ( $52^{\circ}$ ). It thawed on the surface of the banks of the river to the depth of from  $2\frac{1}{2}$  to 6 English feet, and still deeper (6 to 9 feet) on the naked heights. But in the forests, where the light of the sun was intercepted, the thaw reached only from  $\frac{3}{4}$  to 6 feet. If it be true that there are places in forests where the ground is never thawed a foot deep, it would demonstrate how little it is necessary for the ground to be thawed for trees to grow on it. The development of the leaves of the pines depends less on the temperature of the soil than on that of the air in the spring; it only requires that the ground should be so far thawed that the tree may be able to draw from it a sufficient quantity of moisture for its growth. I was convinced of this upon observing in Lapland large leaves already upon the shrubs when the thaw had scarcely reached a foot deep in the swampy soil on which they were growing; but the air was in consequence of the long days (in June) very warm. On one occasion, after having dug down six feet through the frozen ground in these trenches in the district of Nertchinsk, they came upon the pure ice, an archin, or  $2\frac{1}{4}$  feet thick, and inclosing boulders (*gerölle*) of different kinds of rock. According to other observations, made equally in the circle of Nertchinsk by Colonel Tatarinoff, the frozen stratum was not more than six feet thick; and the annual thaw of the superficial stratum in each summer is rather less. The greater thickness of the frozen stratum, in the observations of Captain

Frelse, may be accounted for by the fact that they were made in higher latitudes; nor ought we to forget that the country of Nertchinsk is mountainous, and lies high.

Still further east, again, the perpetual ground ice is found at a less depth southwards, probably because the neighbourhood of the sea raises the temperature of the soil. Erman, at least, found no ice in the soil at Okhotzk.

It seems that Fort Churchill in America, in lat.  $59^{\circ}$  N., long.  $94^{\circ}$  W., lies exactly on the limit of perpetually frozen ice, as the mean temperature of this place is only a little below freezing point.

(Signed) BAER.

II.—*Astronomical Positions in European Turkey, Mount Caucasus, and Asia Minor, fixed by F. G. W. STRUVE, from the Observations by Officers on the Imperial Russian Staff, in the years 1828 to 1832. Communicated by Captain H. G. HAMILTON, Royal Navy.*

[The following important Table of Geographical Positions is extracted from the *Bulletin de l'Académie Impériale des Sciences de St. Petersbourg*.]

DURING the campaigns of the Russian armies in the last Turkish war in Europe and Asia, a series of astronomical and geographical observations was carried on, which were as important as they were remarkable for their extent and accuracy. On the appointment of the Director of the Dépôt of Maps belonging to the Imperial Staff (Lieutenant-General von Schubert), some officers were named to make astronomical observations at the points occupied by the armies, and were for this purpose supplied with a complete set of instruments. These observations were made in European Turkey, from 1828 to 1832, by Captains Vrontschenko, Ortenberg, and von Essen. They made use of two portable transit instruments, two astronomical theodolites, pendulums and chronometers, and telescopes for the observation of occultations, sextants, and a magnetic dipping-needle. In the further Caucasus and in Asia Minor, Captain Birdin worked with similar means, but without theodolites or a dipping-needle. On this side of Caucasus, and at some points of Turkey in Europe, the observations were made by officers of the Topographic corps. These observers had previously followed a complete course of practical astronomy at the Dorpat Observatory. From this circumstance, their labours became an object of peculiar interest to me; and I had much pleasure in undertaking the office of comparing their occultations and lunar culminations with corresponding observations—of deducing the longitudes from them,